BARTLETT

EXPERIMENTAL FOREST

NORTHEASTERN FOREST EXPERIMENT STATION

FOREST SERVICE • 1955 • U.S. DEPARTMENT OF AGRICULTURE

We invite you to visit the Bartlett Experimental Forest whenever you are in the vicinity of Bartlett, N. H. If you would like a guided tour or additional information on any phase of the work that is being carried on, please write or telephone to the White Pine-Hardwood Research Center, Forestry Building, Laconia, N. H. The forestry officer in charge is Victor S. Jensen.

NORTHEASTERN FOREST
EXPERIMENT STATION
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Ralph W. Marquis, Director

BARTLETT

EXPERIMENTAL FOREST

This booklet was prepared by Russell J. Hutnik, one of the foresters who does research work on the Bartlett Forest. The Forest is maintained by the Northeastern Forest Experiment Station, Forest Service, U.S. Department of Agriculture.

THE BARTLETT EXPERIMENTAL FOREST is one of the outdoor laboratories where the U. S. Forest Service carries on experiments to find better ways of growing and using crops of timber (fig. 1).

The research carried on here is part of the work of the Northeastern Forest Experiment Station, which has its headquarters at Upper Darby, Pa. The research foresters who conduct the studies on the Bartlett Forest are members of the experiment station's White Pine-Hardwood Research Center in Laconia, N. H.

The Forest is located in the heart of the White Mountains of New Hampshire, just south of the village of Bartlett (fig. 2). It lies on the northern and eastern slopes of Bear Mountain and the Bartlett Haystacks.

The Forest has been used for research since 1931. A few years earlier (in 1928) Congress had authorized a large-scale forest-research program. The U. S. Forest Service had set up regional forest experiment stations throughout the country, including one to tackle the forestry problems of the New England-New York region. As part of this program, the White Mountain National Forest in 1931 set the Bartlett Forest aside for experimental purposes, particularly for studies in management of northern hardwoods.

FIGURE 1.--Headquarters of the Bartlett Experimental Forest. Offices and living quarters are provided for research personnel.

Since its establishment, four dates stand out in the development of the Bartlett Forest:

1933. The Civilian Conservation Corps established a camp at Bartlett. This made possible the beginning of a research program on a large scale. The camp provided manpower; it also offered a ready outlet for fuelwood.

1938. The hurricane in September 1938 swept over parts of the Experimental Forest and caused a lot of damage. Some of the studies in progress had to be interrupted while salvage operations were carried on. On some of the study areas the damage was so great and the experimental treatments were so confounded that plans had to be changed.

1941. World War II brought a temporary halt to the research activities on the Forest. However, a limited number of periodic remeasurements of sample plots were still made.

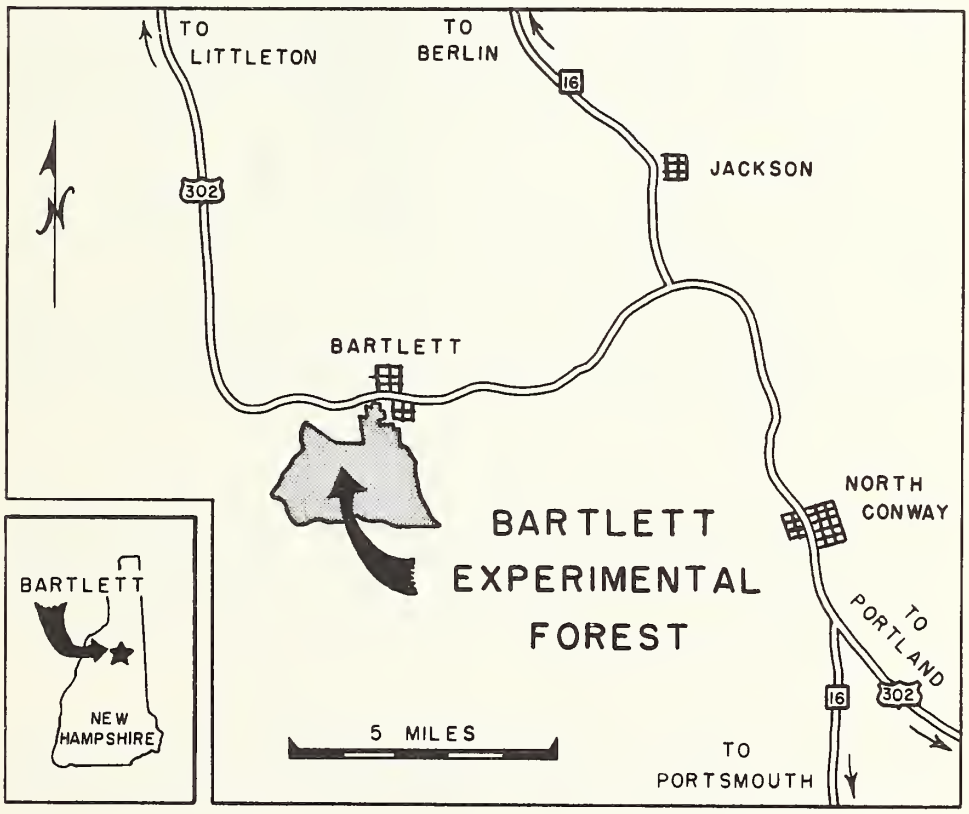
1950. Research activities were again expanded and accelerated.

DESCRIPTION OF
BARTLETT EXPERIMENTAL FOREST

Just why was this area chosen as an experimental forest? The answer is that on this one area of 2,600 acres we find many of the forest conditions that are typical of the 8 million acres of northern hardwood forests in Maine, New Hampshire, Vermont, and western Massachusetts. A look at the history of this Forest tells us why:

LAND USE The first commercial logging began on the Forest about 1870. From then till about 1900, the area was logged over a number of times. In each operation, only the best trees were taken. The first cuts were for spruce logs. In later operations, the best sugar maple

FIGURE 2.--The Bartlett Experimental Forest is in the heart of the White Mountains near the towns of Bartlett, Jackson, and North Conway. It can be reached by highways U.S. 302 and N.H. 16.



and yellow birch trees were cut. But seldom was any beech cut. These practices greatly increased the proportion of beech in the stands (fig. 3).

During this period, a logging railroad was built from Bartlett through the Forest into the Passaconaway Valley. Since the locomotives burned wood, many of the hardwood stands along the right-of-way were clear-cut for fuel. Some logging camps were built on the lower, more level part of the Forest. The surrounding land was cleared, and for a short time it was used for pasture.

By about 1900, all the better trees had been removed. Then the loggers left, the pasture was abandoned, and the railroad stopped operations.

By 1914 this land where the Bartlett Experimental Forest now stands was bought by the Federal Government. It was part of a 45,000-acre tract the Government bought to add to the White Mountain National Forest. During World War I another logging operation was conducted on the Forest. This time the cut was for hemlock bark for tannin. Small cuts were made from year to year for fuelwood and paper birch boltwood.

FOREST COVER

This past land use is largely responsible for the forest conditions that exist today on the Experimental Forest. Old-growth northern hardwood stands cover most of the area (fig. 4). These stands are made up of large--and mostly--defective trees that were left in the early cuttings, and smaller trees that came in as a result of these cuttings. Beech is the predominant species. Yellow birch, sugar maple, and hemlock make up almost all the rest of the stand.

Areas that had been clear-cut and the abandoned pastures now support second-growth, even-aged hardwoods (fig. 5). These stands, composed mostly of red maple, paper birch, and aspen, range in age from 30 to 70 years.

Red spruce stands cover the higher slopes. These were especially hard hit by the 1938 hurricane. Softwood stands--red spruce, balsam fir, and hemlock--occur on localized wet areas on the lower part of the Forest. A narrow band of white pine is located just behind the headquarters area.

TREE SPECIES

Almost all the volume on the forest is in eight species--beech, yellow birch, sugar maple, eastern hemlock, red maple, paper birch, white

ash, and red spruce (fig. 6). Aspen and balsam fir are also important components of some of the second-growth stands. But, because they are short-lived, they are seldom found in the older stands. Other species found in limited quantities on the forest are white pine, red pine, red oak, basswood, black cherry, black ash, American elm, pin cherry, hop hornbeam, and striped maple. The distribution of the major species is as follows:

Species	Proportion of total volume
	Percent
Beech	28
Yellow birch	15
Sugar maple	10
Hemlock	8
Red maple	11
Paper birch	10
White ash	2
Red spruce	15

The large number of species creates many problems. For example, some trees, like white ash, sugar maple, and the birches, have a high value; others, like beech and red maple, have a low value.

Some, like white ash, sugar maple, and hemlock, grow fast; others, like yellow birch, grow slowly. Some, like beech and red maple, tend to be defective and rot easily; others, like sugar maple and white ash, are usually sound and of good quality. Some, like beech and sugar maple, grow well in the shade of other trees; others, like paper birch and aspen, require exposure to direct sunlight. Some, like white ash, require good sites.

And some are readily attacked by insects or diseases. For example, many of the large beech trees are killed by the beech scale-Nectria complex, and birches frequently deteriorate after excessive exposure due to heavy cutting.

ROADS & MARKETS

Roads and markets always must be considered in managing a forest; you must be able to get at the timber so you can cut it, and after it is cut you should have markets for it. In this respect, the Bartlett Forest is about typical. Transportation facilities are good. The Forest is easily reached from Bartlett by the

Bear Notch Road. And within the forest is a well-developed system of gravel roads. U.S. Highway Route 302, which goes through Bartlett, provides access to the surrounding territory.

Within 65 miles of the Forest, good markets can be found for the timber products harvested. There are ready outlets for sawlogs, low-grade veneer logs, pulpwood, paper birch boltwood, and ash handle stock. All these products are cut on the Forest.

TOPOGRAPHY & SOILS Elevations on the Forest range from 680 feet near the administration headquarters to 2,995 feet at the summit of Bartlett Haystack. The lower part of the Forest has a gentle slope. In some places the land is level enough to form small swamps. These swamps make up only a small part of the Forest, but they complicate logging in those areas. The upper part of the Forest is steep. Some areas are too steep and rocky to be logged. Rock outcrops and ledges are common at the upper elevations.

The soils are podzols derived from glaciated granites and schists. The soils are moist, but there are only a few areas where the drainage is poor. Boulders and rocks are common in most parts of the forest. In many places the soil mantle is shallow.

THE LOCAL CLIMATE The climate is characterized by cold winters and warm summers. Although temperatures above 90° occur nearly every summer, nights are usually cool. Sub-zero readings are quite common during the winter. During the period 1934-41, the temperature extremes recorded at the administrative headquarters have been 96° F. and -26° F. During that same period, freezing temperatures were recorded as late as June 8 and as early as August 27.

Deep snow is the outstanding feature of the winter at Bartlett. As much as 6 feet of snow accumulates. Individual snowstorms that deposit 2 or more feet of snow are not uncommon. Snow depths and accumulations on the experimental forest vary considerably with elevation.

The average annual precipitation of about 50 inches is evenly distributed throughout the year. Rarely do intense storms occur. The hurricane of 1938 was a notable exception.

MULTIPLE USE The main function of the Forest is research. But like the rest of the National Forest land, it is a multiple-use area. Water, wildlife,

FIGURE 3.--Northern hardwood stands contain a large proportion of defective beech trees. These trees were left from earlier cutting operations when the stand was "creamed" for better trees.

FIGURE 4.--One of the better old-growth hardwood stands on the Bartlett Experimental Forest.

FIGURE 5.--A typical second-growth stand on the Bartlett Experimental Forest. This stand is 50 to 60 years old, most of it red maple and paper birch.

FIGURE 6.--White ash--the large tree at left--is one of the eight major species found on the Bartlett Forest. The large red oak, right, is not so common.

FIGURE 7.--One of the eye-catching vistas seen from the Bartlett Experimental Forest. In the background is Mount Washington.

and recreation are also important resources of the Forest.

A large part of the watersheds of two streams--Bartlett Brook and Albany Brook--are on the Forest. The village of Bartlett gets its water supply from a reservoir located within the Forest. The studies on the Forest are designed to preserve this water resource.

Many species of wildlife are found on the experimental forest, including deer and bear as well as smaller animals. The Forest is open to hunting and fishing during the regular seasons.

The graceful trees and the tumbling brooks make the forest interesting to the camera fan as well as to the forester. Three vistas along the forest road bordering the Experimental Forest provide some of the best panoramas in the White Mountains (fig. 7). These views are at their best in the early fall when the first snowstorm covers the mountain tops with a mantle of pure white, while the slopes are ablaze with the vivid colors of autumn.

THE RESEARCH PROGRAM

The research program at the Bartlett Experimental Forest is designed to solve the more important forestry problems of the northern hardwood region. This program can be divided into two broad classes: (1) small-plot studies, and (2) applied forest-management studies.

As a result of small plot studies made in the past, both in the Northeast and in the Lake States, we now have a good knowledge of the ecology and silviculture of northern hardwoods. For the most part, these have been individual studies, limited in scope as well as in size. They were de-

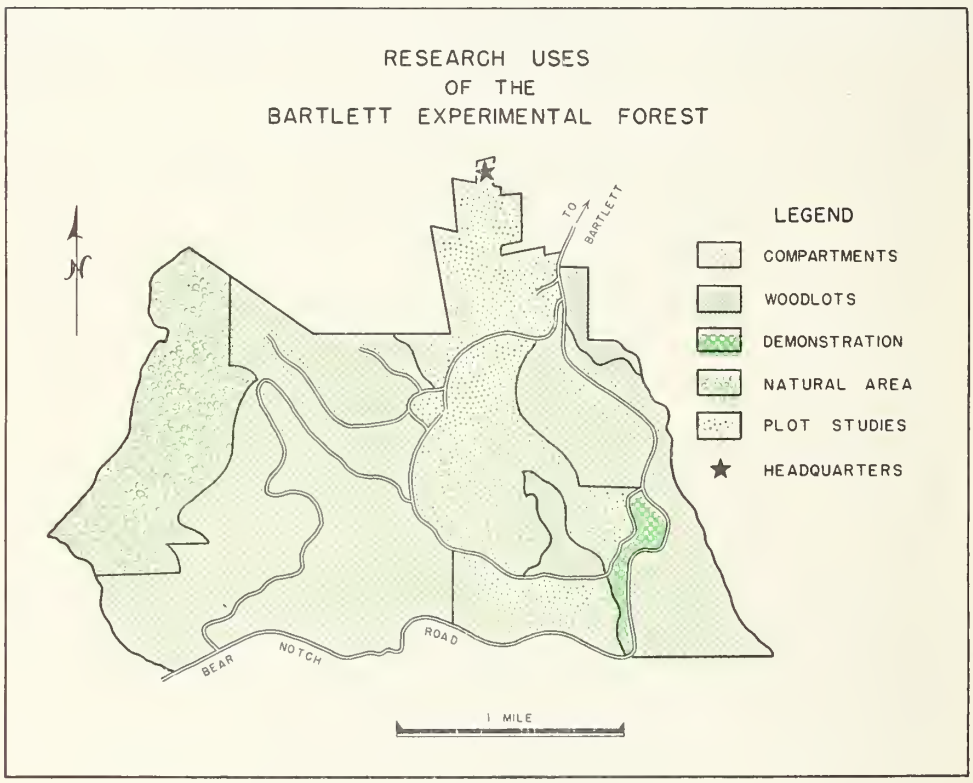


FIGURE 8.--The land on the Bartlett Forest has been allocated to various research uses. Some areas have been reserved for future studies.

signed to answer specific problems under selected conditions of type, stand age, composition, and density. There is a continuing need for this type of research to fill in the gaps in our present knowledge and to answer new problems as they arise.

The immediate problem facing a forest owner is to find the best method of applying all this knowledge in managing a forest stand. He wants to know what silvicultural program will give him the best returns over a long period of time. Much of the research program on the Forest is designed toward providing answers to this problem.

The Experimental Forest has been divided into a number of areas, each with a specific use (fig. 8). These uses and the acreage assigned to each are:

Use	Acres
Compartment studies	1,324
Small plot studies and reserved space for future use	673
Woodlot-management studies	80
Demonstration area	38
Natural or undisturbed areas	485
Total	2,600

Compartment Studies

Over half of the area of the Experimental Forest has been set aside for compartment studies. This is our major project in applied forest-management research. The compartments are large enough--about 50 acres--to provide for commercial-size logging operations.

Each compartment is treated according to a definite plan (table 1). These range from a very intensive kind of management to a complete disregard for future forest production. The intensive management usually tends toward short cutting cycles, long rotations, stand-improvement practices, and careful logging; it maintains growing stock at a high level.

As the intensity of management is lessened, the value and quality of the forest that is maintained usually lessens. The extreme is reached on the compartments where no forest management is applied: there the forest is cut for whatever can be got out of it, and only unmerchantable trees remain. Cuttings can be made only at long intervals.

The purpose of these studies is to evaluate the various management systems. This is done by collecting complete cost and return data as well as silvicultural data (fig. 9). The merit of each system will depend on the amount of money we get for the products, the amount we spend on logging and stand improvement, and the amount by which we increase or decrease the value of the stand.

Table 1.--Design of compartment study project

Management level	Product objective[1]	Silvicultural system	Cutting cycle	Growing stock level[2]		Compartments
			Years		Sq. ft. of basal area	No.
Very intensive	High value	Selection	5	High	100	1
				Medium	80	1
				Low	60	1
			10	High	100	2
				Medium	80	2
				Low	60	2
		Patch	5	--	--	1
			10	--	--	2
Intensive	High value	Selection	10	High	100	1
				Medium	80	1
				Low	60	1
			20	Medium	80	2
				Low	60	2
	Low value, with some high-value specialties	Patch	10	--	--	1
			20	--	--	2
Extensive	Some high value, but mostly bulk	Rigid diameter limit	20	--	60	1
			20	--	40	1
			40	--	40	1
None	Whatever can be harvested	None	40+	None		2
					Total	27

[1]Implies integrated utilization of all products available.

[2]In trees 5 inches d.b.h. and larger. As a rough conversion factor, 1 square foot of basal area is approximately 20 cubic feet of volume, or about $\frac{1}{4}$ cord.

These studies are designed to provide the owners of northern hardwood forests with a good guide for managing their properties. They should help him answer, from both silvicultural and economic viewpoints, a number of important questions such as:

What is the best forest capital to maintain, and what is the best method of achieving it?

Which is the best in the long run: a large income at rather long intervals or a smaller income at shorter intervals?

How much of his income should he re-invest in stand improvement?

What stand-improvement practices will give him the most for his money?

What types of products should he try to grow?

What is the best method of logging his forest?

What special measures are needed to protect the stand from logging damage?

In these studies there are 27 compartments--19 in old-growth stands and 8 in even-aged second-growth stands. Since they are fairly uniform with respect to site and stand conditions, we will be able to compare the results of the different systems.

Each compartment is marked by research foresters in accordance with the prescribed treatment. The logging is done by a private operator to provide cost and return data that are realistic. Two or three compartments are cut each year. The first ones were cut during the winter of 1950-51. By 1961 all of the compartments will have been cut over at least once.

Demonstration Area

The compartment study involves a total of 27 compartments and over 1,300 acres of forest land. Interested persons would find it too difficult and time-consuming to visit each one. Therefore an area has been set aside to demonstrate the typical treatments.

This demonstration area consists of four 5-acre plots located along the Bear Notch Road (fig. 10). A trail through the plots enables the visitors to take a closer look at the treatments. The treatments shown here are:

Plot 1. LIGHT SELECTION CUTTING
Hold: 100 square feet of basal area
Cutting cycle: 5 years

Management level: Very intensive
Product objective: High-value
Remarks: Characterized by carefully selecting the individual trees to be cut or left, carefully laying out skid roads to protect watershed values, taking special care to reduce logging damage, and, where necessary, applying such cultural practices as killing defective trees and thinning.

Plot 2. MODERATE SELECTION CUTTING
Hold: 80 square feet of basal area
Cutting cycle: 10 years
Management level: Intensive
Product objective: High-value
Remarks: Logging and cultural practices similar to Plot 1 except on a less intensive scale.

Plot 3. DIAMETER-LIMIT CUTTING
Cut: All trees over 15 inches in diameter
Hold: 60 square feet of basal area
Cutting cycle: 20-30 years
Management level: Extensive
Remarks: Characterized by heavy cutting and a minimum of cultural work; no consideration given to spacing, quality, or vigor of growing stock left.

Plot 4. POOR CUTTING
Cut: All marketable trees
Hold: Only the poorest trees
Management level: None
Remarks: No consideration given to future crops or to watershed values.

Woodlot-Management Studies

Since a large part of the timber in New England is on small woodlots, it is important to find out how these small forest properties should be handled. Two areas of about 40 acres each have been set aside as typical small woodlots for experimental purposes.

These woodlots are being used to test various management methods to find what kind of management is good for small woodlots. Stand records and records of costs and returns are kept. These areas also serve as demonstrations of small-woodlot management, to show the woodlot owner how he can improve his piece of forest.

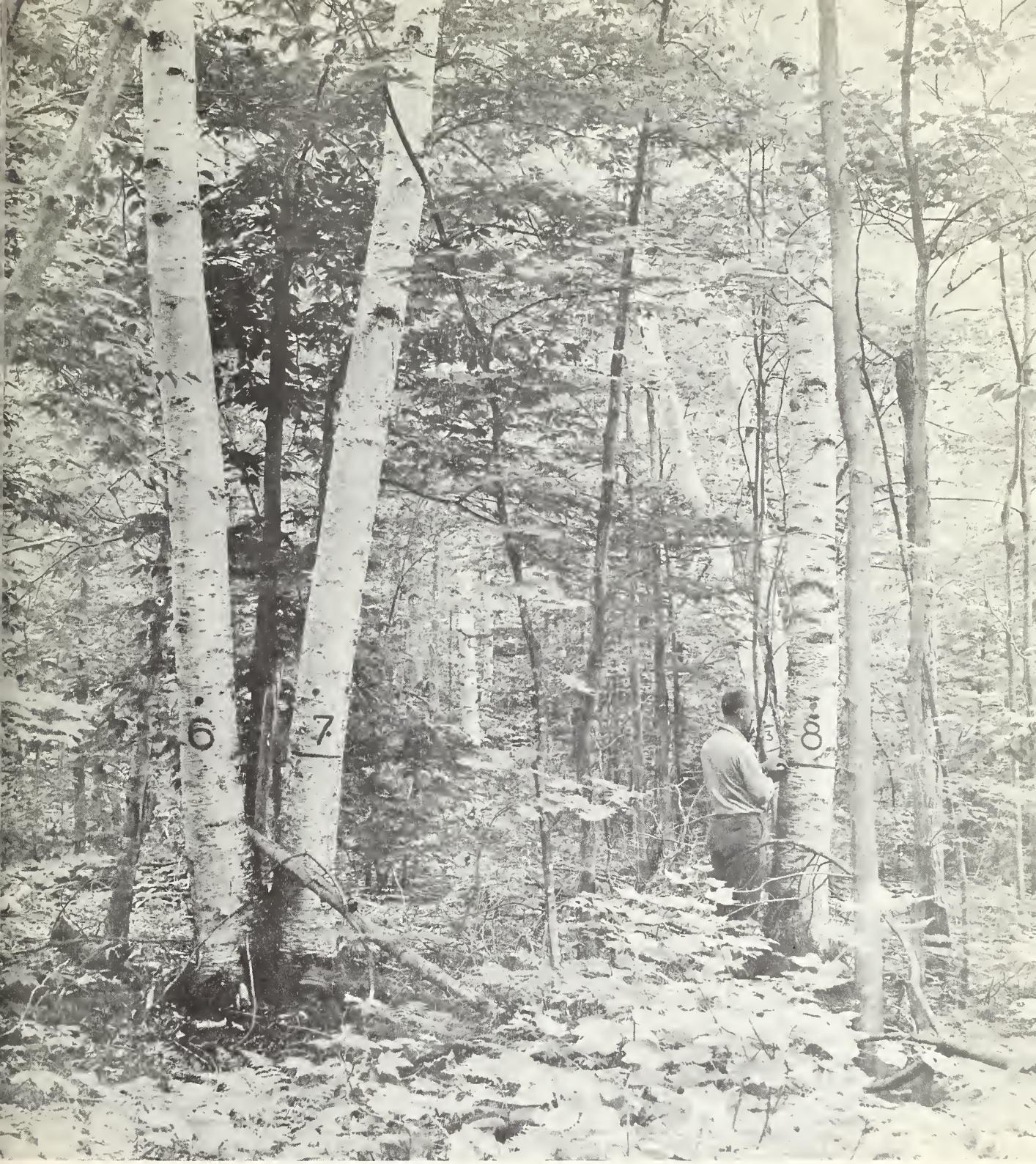


FIGURE 9.--A research forester measuring sample plot. In some studies all the trees are permanently numbered and detailed data are kept.

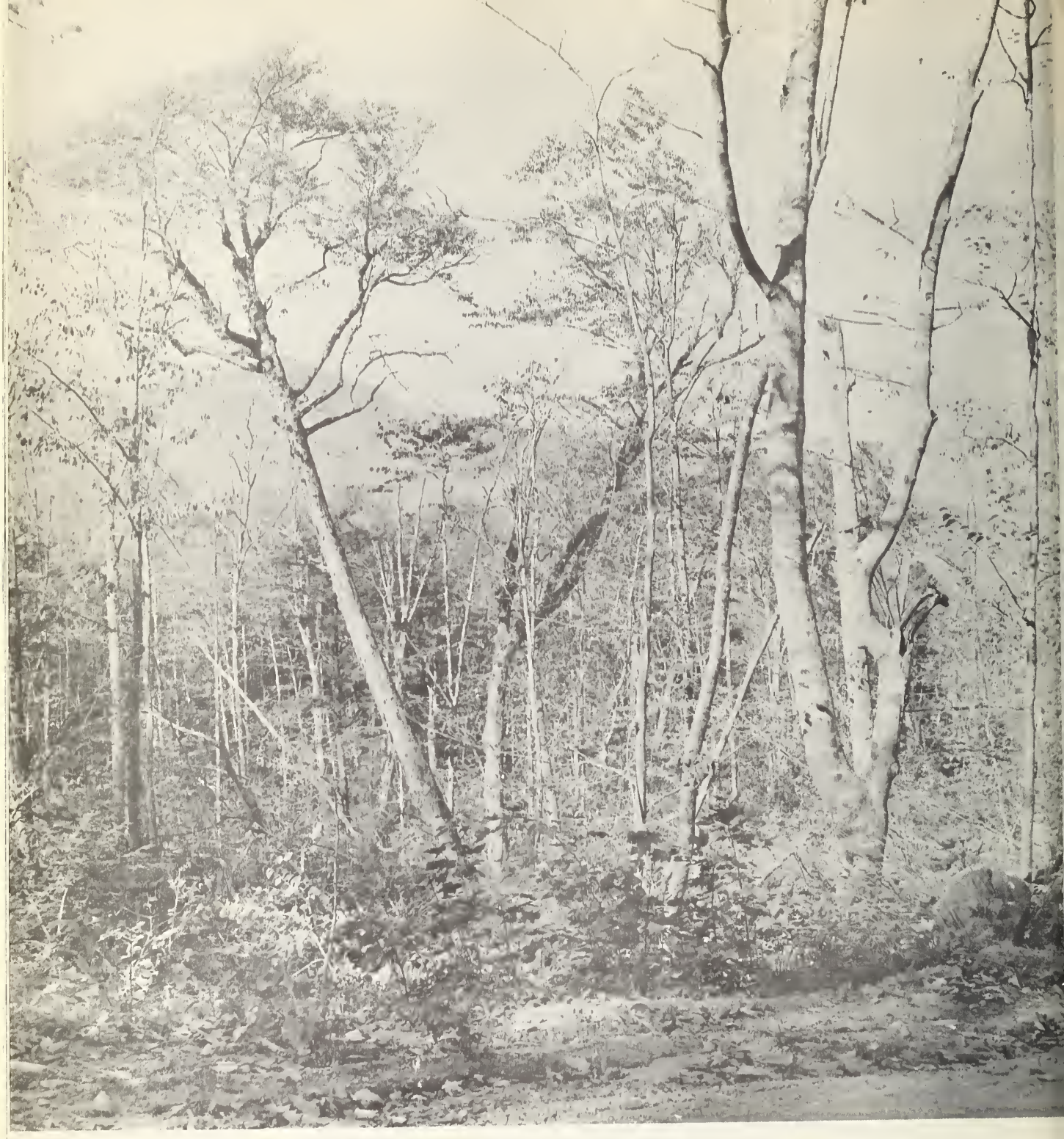


FIGURE 10.--One of the demonstration plots along Bear Notch Road. On this plot, all merchantable material was removed, leaving only cull trees that probably will become wolf trees as the new stand develops.

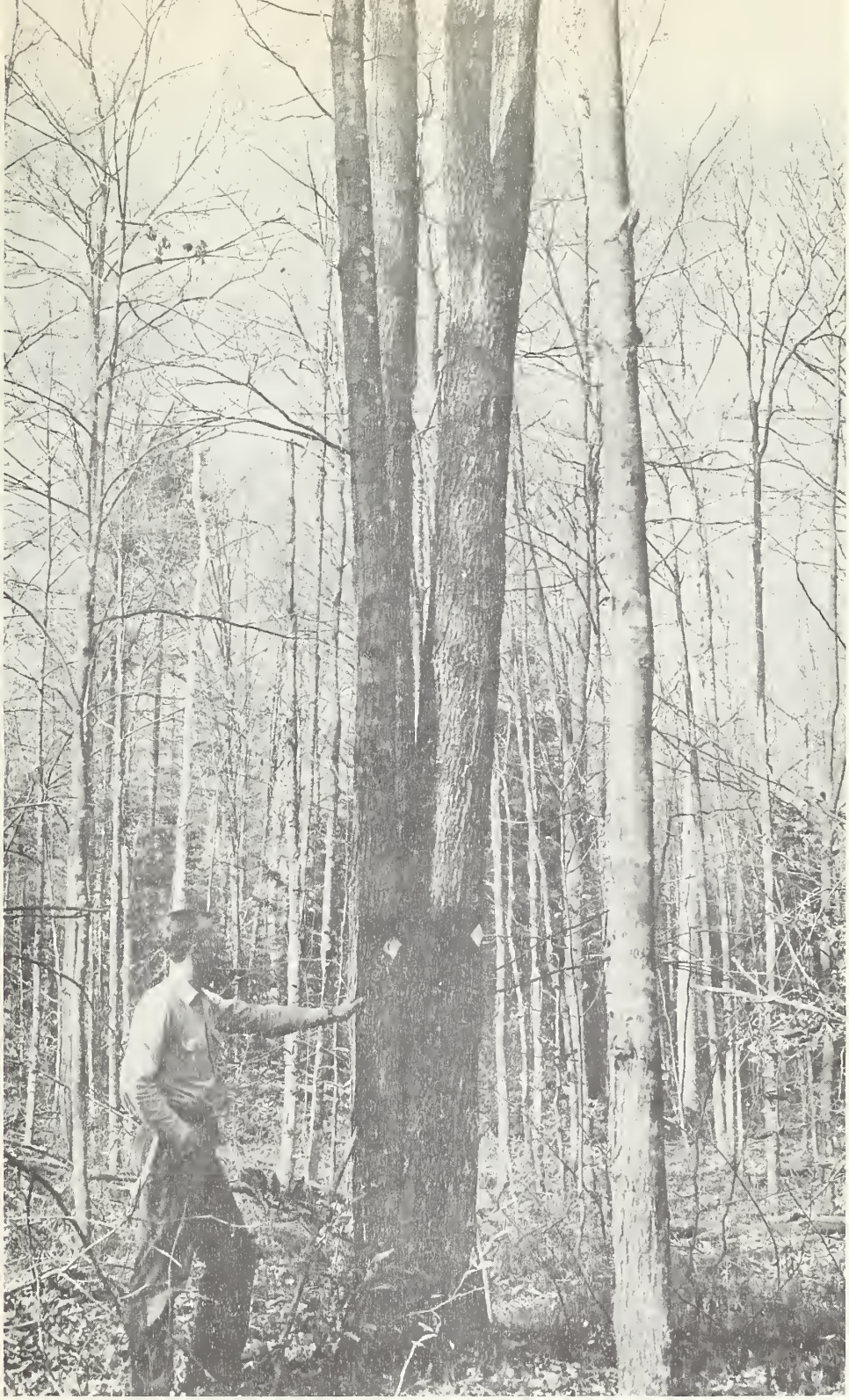


FIGURE 11.--Red maple sprout clumps were among the first trees marked for cutting in the second growth woodlot.

FIGURE 12.--Loading pulpwood with a farm tractor. Farm equipment can be used in a number of the woodlot operations.

Both areas are typical of the woodlots in the region. Both are easily accessible and have comparatively gentle topography. Because of past use, growth and quality are poorer than they should be.

One woodlot has a large proportion of old-growth hardwoods. But many of these trees are of low quality and contain much unusable material. The best trees had been removed in logging operations about 60 to 70 years ago.

The other woodlot is mostly in second-growth hardwoods with scattered large trees of low value (fig. 11). These stands came in after clear-cutting on some areas as late as 1917. The trees are small, but many show promise of developing into valuable timber trees.

The initial cut on both woodlots was made in 1952 (fig. 12). Logging on the woodlot stocked with small-sized trees was a marginal operation. The other woodlot was more heavily cut over and yielded a good income. Future plans call for making cuttings annually on one or both areas.

Small Plot Studies

There are a number of special "test-tube" studies now in progress on the Experimental Forest. Briefly, these are:

METHODS OF CUTTING IN OLD-GROWTH STANDS — This study was started in 1933. Its purpose is to evaluate the merits of three widely different silvicultural systems for use in northern hardwoods (figs. 14, 15, and 16). These systems, and the current acreages involved, are: Selection cutting (25 acres), clear-cutting (23 acres), and clear-cutting in patches (10½ acres). The 10½ acres is made up of 30 patches, 0.1 to 0.7 acre in size, scattered over more than 100 acres.

FIGURE 13.--The major products from the second cut on the second-growth woodlot were pulpwood and paper birch boltwood.

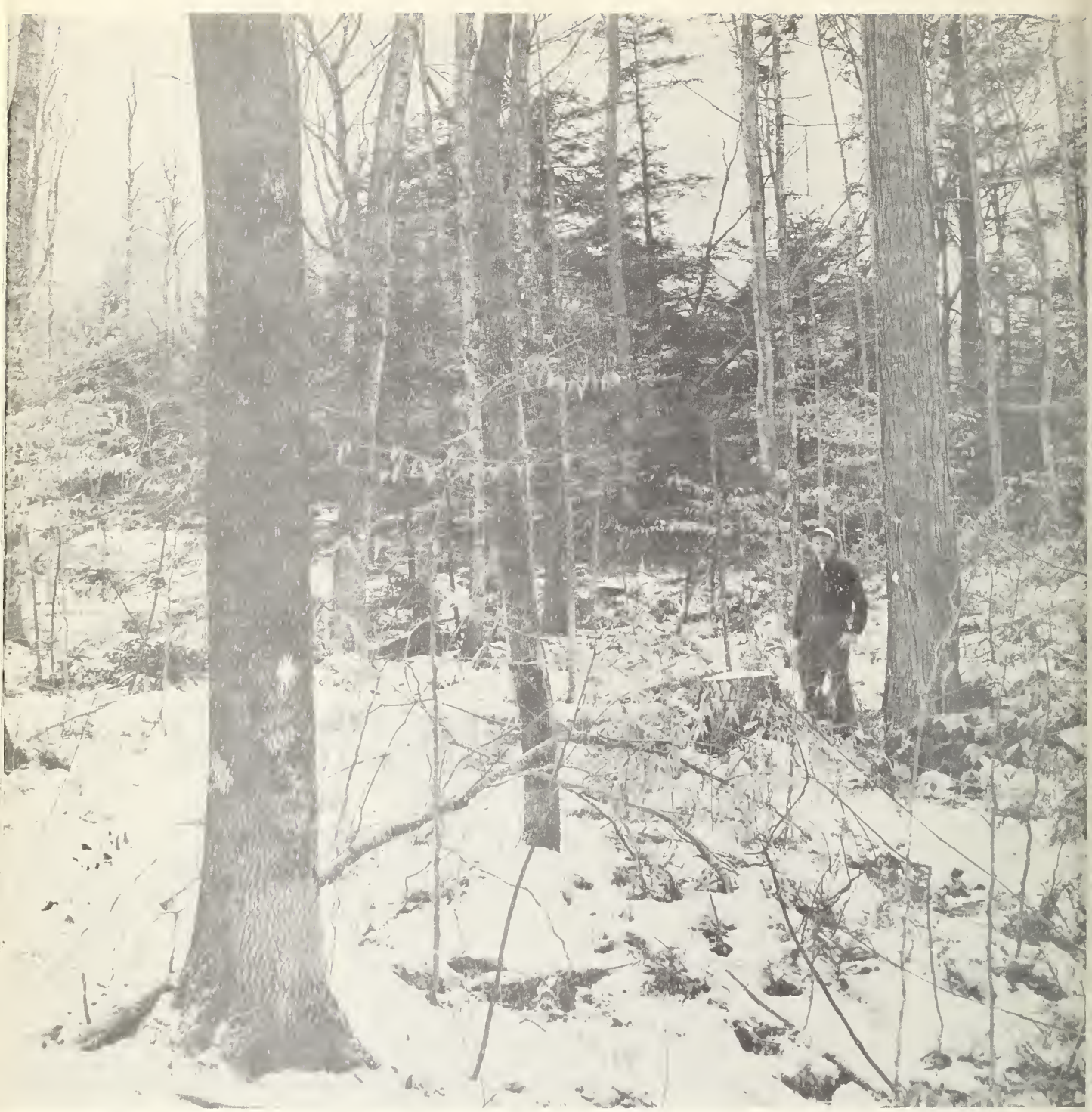


FIGURE 14.--An example of the selection cutting on the Bartlett Forest. This system maintains a stand of good-quality, vigorous trees in all diameter classes.

FIGURE 15.--One of the patch cuttings on the Experimental Forest. Clear-cutting in patches of about 1/4 acre favors the regeneration of yellow birch.

FIGURE 16.--An example of clear-cutting. A few ash trees were left here as seed trees. Completely removing the overstory in an old-growth northern hardwood stand favors paper birch and aspen reproduction.

To date, two cuttings have been made on the selection and patch-cutting plots. Nothing has been done on the clear-cut area since the time of cutting. Records are kept on the volume removed, growth, mortality, and reproduction.

Preliminary results indicate that all three methods have a place in the management of old-growth northern hardwood stands. The choice lies largely in the condition of the stand and the product desired. The selection system maintains a stand of good-quality trees in all diameter classes. Clear-cutting sacrifices the smaller but potentially valuable trees, but it is the best system where aspen and paper birch reproduction are desired or where almost all the trees in the stand are defective. Patch-cuttings give somewhat intermediate results: a large part of the yield is in bulk products, but the proportion of yellow birch reproduc-

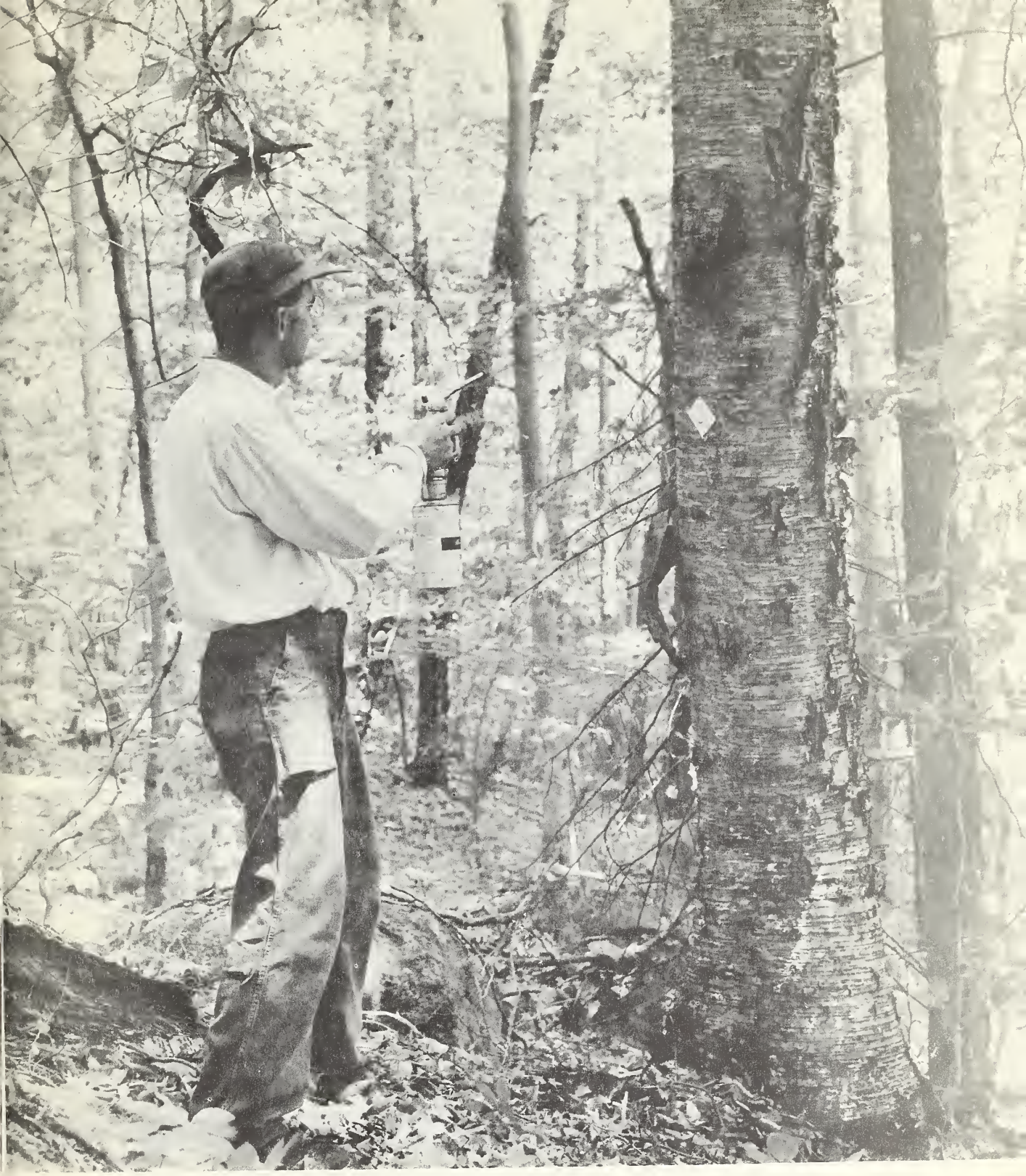


FIGURE 17.--Marking a poor-risk yellow birch tree for cutting.

tion is higher than under the other systems. Patch cutting is best suited for stands containing small areas of large decadent hardwoods.

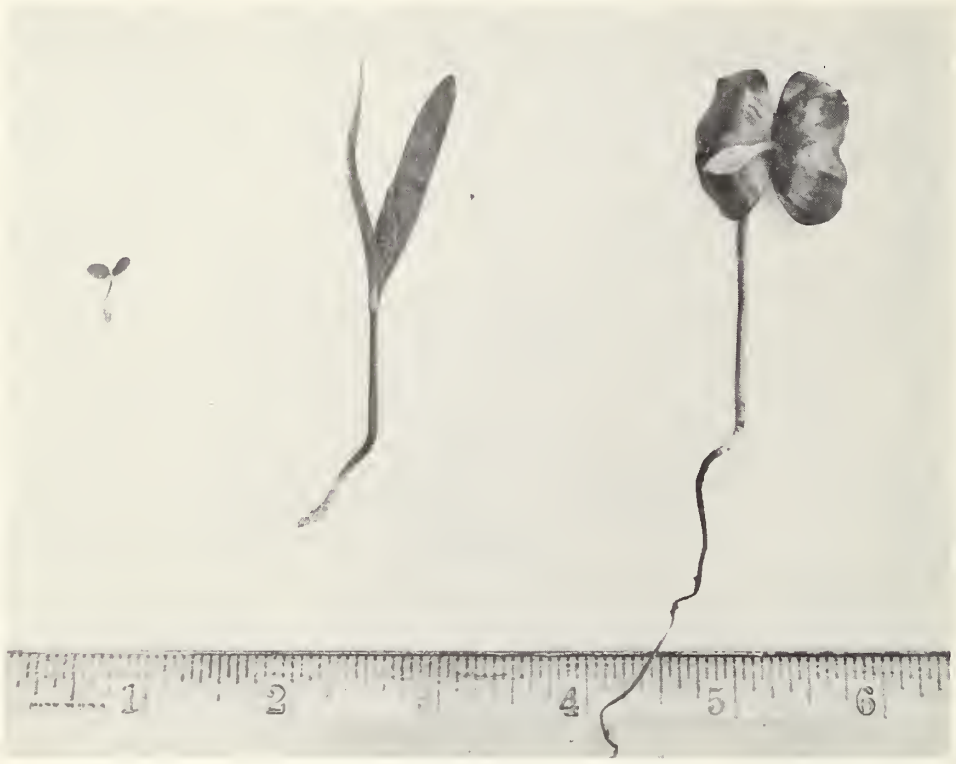


FIGURE 18.--Research studies on the Bartlett Forest cover a range from germination of the seed to harvesting of the product. These are cotyledon stages of three of the most important northern hardwood species. Left to right: yellow birch, sugar maple, and beech.

THINNING SECOND-GROWTH STANDS

In 1936, a thinning was made on 17 acres of a 60-year-old stand of second-growth northern hardwoods. A second thinning was made in 1952. Records were kept on growth, mortality, and volume removed. At the present time, the growth, quality, and vigor of the thinned stand are much better than on an adjacent unthinned stand. In addition, the aspen and the valuable paper birch were harvested before they became overmature and died.

FIGURE 19.--Forest insect and disease studies are made at the Bartlett Forest. This is a beech tree with a heavy infestation of beech scale.

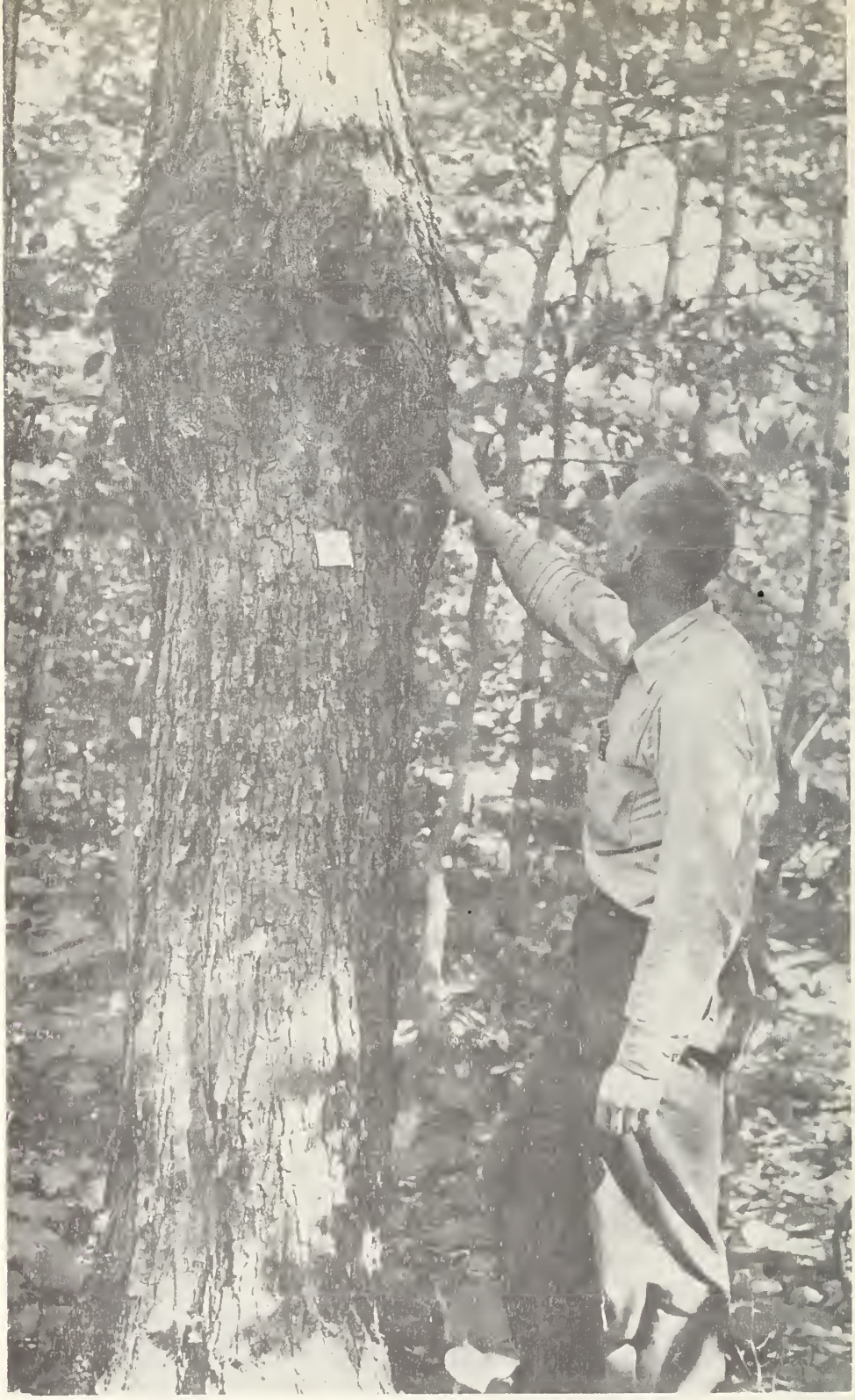


FIGURE 20.--A large sugar maple, showing the kind of deformity that results from attack by the sugar maple borer.

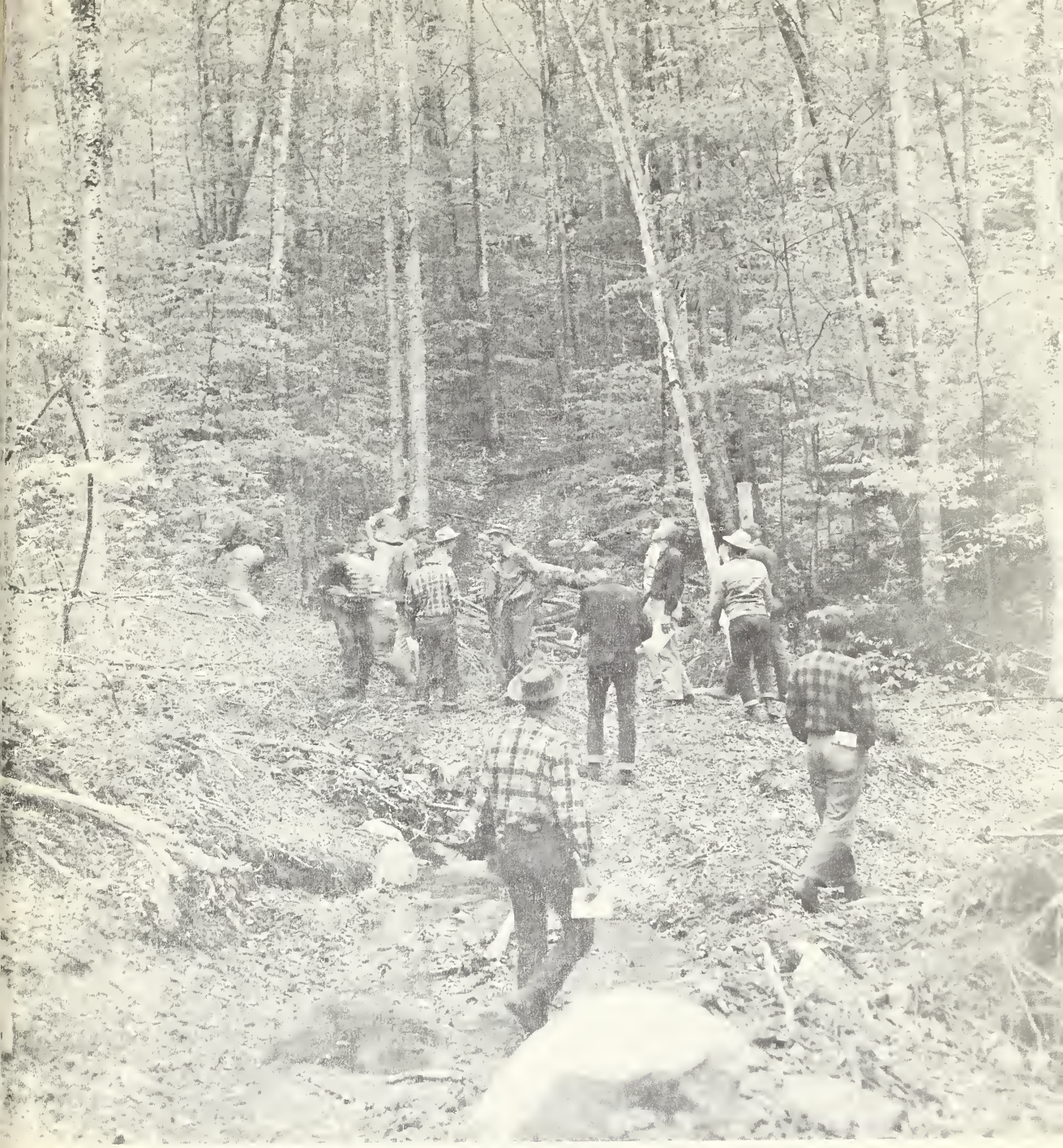


FIGURE 21.--A group of forestry school students visiting one of the experimental areas. Groups of foresters, students, and other interested people visit the Forest every year to get first-hand information about the studies carried on.

CLEAR-CUTTING SECOND-GROWTH STANDS

After the 1938 hurricane, 1½ acres of a severely damaged second-growth stand of northern hardwoods was clear-cut. Records were kept on the reproduction following cutting. Unlike on the clear-cutting in old-growth stands, reproduction of desirable tree species was poor. Part of the area is still covered with a dense growth of blackberry bushes. One possible reason for these poor results was the lack of advance reproduction in the second-growth stand.

YELLOW BIRCH DECADENCE

In 1931, a small plot in a 50-year-old stand containing a high proportion of yellow birch was thinned (fig. 17). Almost half of the basal area was removed in this operation. Records were kept of the growth, crown condition, and mortality of the residual trees. Although the net growth on the cutover plots was twice as great as that on the uncut plots, more trees died, and more showed serious decadence of their crowns. Yellow birch benefits from thinnings, but these thinnings must be light enough to prevent post-logging decadence or excessive mortality.

PAPER BIRCH DECADENCE

In the spring of 1952, a 70-year-old stand containing a high proportion of paper birch was thinned. About 30 percent of the basal area was removed. Each tree showing symptoms of post-logging decadence since thinning was classified according to vigor and degree of damage. It is still too early to note any definite trends on the decadence of mature paper birch following a moderate thinning.

PAPER BIRCH REPRODUCTION

Paper birch, one of our most valuable species, is difficult to regenerate successfully. In 1951, a study was started to find ways to insure a good catch of paper birch reproduction. Part of the study consisted of a survey of a number of young paper birch stands to determine the conditions existing when they became established. Various seedbed treatments were also given to a series of small plots located in a partially cut paper birch stand. These were: (1) mineral soil exposed; (2) humus layer exposed; (3) burned; and (4) untreated check. As yet we know of no sure way of getting paper birch reproduction. But by completely removing the overstory and exposing the mineral soil, we can create the best seedbed conditions for it. Paper birch reproduction can be obtained without burning.

BEECH SCALE-NECTRIA

Since the early 1940's, the beech scale-Nectria (an insect-disease complex) has been killing many of the large beech trees in the White Mountains (fig. 19). Since beech is an important component of the northern hardwoods stands, a number of projects have been started to find practical means of controlling this pest.

Both chemical and silvicultural control methods have been tested. We found that periodic spraying of the trunks with DDT solution is an effective control for the beech scale. However, such a method is probably too expensive for long-term control.

A better method--if such a method exists--would be to keep the stand in a healthy condition through proper cutting. Various intensities of thinning as a means of control have been tested. None of them, however, have been successful in keeping down the scale population.

Natural Areas

Almost 500 acres have been set aside as "natural areas." These areas, like the rest of the Experimental Forest, have been cut over in the past. However, no cutting will be done in the future. They will provide a place to study the development of the forest under undisturbed conditions. The effects of man's treatment--good and bad--can be compared to that of Nature.

MAKING RESEARCH RESULTS KNOWN

The purpose of all this work on the Bartlett Experimental Forest is to find better ways of growing crops of northern hardwood timber. But the job does not end there. For no research job is done until the results have been made known so other people can put them to use.

One way the results are made known is by publication. Our research men prepare reports for publication in various professional journals and trade journals. They prepare material for use in newspaper articles and stories in popular magazines.

Demonstrations have also been found effective for showing research findings. "Show-me" trips are arranged for groups or individuals who are interested in seeing the re-

search projects under way on the Bartlett Forest (fig. 21). As already mentioned, a special demonstration area has been set up as a sort of show case, where the visitor can see at one stop the effects of various treatments, both good and bad.

The results of research on the Forest have been found useful not only by other research men, but also by both public and private foresters, landowners, timber operators, and students.

AGRICULTURE-FOREST SERVICE-UPPER DARBY